FUEL CHOICES IN ETHNOGRAPHY AND ARCHAEOBOTANY

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Choice of fuel in ethnography

It has long been noticed that the residues of a burned fuel occupy a large proportion of the macro-botanical remains obtained by flotation [Miller and Smart 1984; Reddy 1998; Valamoti 2013 and the other papers in Environmental Archaeology, volume 18(1)]. Various combustible materials, such as wood, dung, chaff, straw, roots, or dry herbaceous plants, can be used as fuels for traditional ovens and hearths. Depending upon their nature, these fuels are used for different purposes, and the ethnographical records show that their characters are well recognized by the users.

In general, the wood is easy to light and quick to burn, whereas the dung is hard to light and produces long and steady fire. To take advantage of these characters, the dung is generally used for long-time cooking, like simmering, stewing, or boiling large amount of water [e.g. Sweet 1960]. The wood is appreciated in various purposes, especially in heating bread ovens. However, the straw and chaff burn out more quickly, and therefore are not used as the main fuels, but are often used to start a fire.

Often, the different types of fuel are used at the different stages of cooking. In a village of Ainata in west Syria, one family used dried chickpea, and another family used torn pages from the textbooks to light olive branches. In the Nile Delta, a bread oven is heated with three kinds of fuel in the order of the amount of smoke produced by them, starting with the corn straw, which is followed by the cotton stem and dung cakes [Rizqallah and Rizqallah 1978].

Furthermore, the quality of the firewood depends on the species of the wood used. In a detailed study on the forest utilization of Jebala in Morocco, the pistachio and oak woods were reported as "very good fuels", the grapevine wood was favored for bread ovens, and the poplar and carob woods were regarded as "poor fuels" [Peña *et al*. 2003: Table 1]. In Jordan, the branches of a Chenopodiaceae plant, *Suaeda* sp., are used for high-temperature burning [Hather 1993: 74]. Olive is generally regarded as a good firewood in the Mediterranean, and the medieval cookbook also recommends the use of dried olive branches for cooking, but instructs to avoid fig because it produces much smoke [Arberry 1986: 38–39].

In dry regions, like western and central Asia, sometimes the dung is the only fuel choice. Even so, people choose the right type of dung because the nature of dung varies with the animal, season, and method of preparation. In Kizilkaya in central Turkey, people use eight different types of the dung fuel for different occasions; they use only the dungs of sheep and cow as fuels, but reject the dungs of donkey and horse. The hard, dense, and compact types of dung are used for long-lasting heat, whereas the unprocessed dung or light summer dung cakes are used to light fire [Anderson and Ertug-Yaras 1998].

The dung of equids is avoided as a fuel probably because of its relatively high content of the undigested fibrous matter, which burns up quickly. However, probably for that reason, the dung of camel is preferred for baking bread on *saj*, a convex metal plate, by the Bedouins in southern Levant [Palmer 2002: 179]. Thin, unleavened bread-baking on hearth does not require long-lasting heat; therefore, in Malyan (Iran), the light-burning fuels, such as straw and dry herbaceous plants, are used for baking on the metal plate, whereas the wood and dung fuel are used for the other firing

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Table 1 Fuels used in bread baking

Village	Bread type	Fuel type	Source
Southern Levant			
Abtaa	*tabun*	cow's dung and wood	Mulder-Heymans 2002
North Jordan	*tabun*	dung (wood to start fire)	McQuitty 1984
Ajlun	*tabun*	dung or wood	Ali 2009
Bedouins	*saj* and hearth	camel's dung	Palmer 2002
West Syria			
Areha Nsebeen	*tannur*	Wood	Mulder-Haymans 2002
Tell Toqaan	*tannur*	Wood	Sweet 1960
Ainata	*tannur*	wood (herbaceous plants to start fire)	Author (summer in 2009)
East Syria			
Tell Beydar	*tannur*	wood, branch, straw	Galan and Al-Othman 2003
As=Suwar	*tannur*	stem of cotton	Mulder-Haymans 2002
Tarif	*tannur*	stem of cotton	Mulder-Haymans 2002
Anatolia			
Bismil region	*tannur*	dung (wood and cotton to start fire)	Parker 2011
Salat	*tannur*	wood (herbaceous plants to start fire)	Author (summer in 2008)
Asvan	brick oven	chaff	Weinstein 1973
Kizilkaya	*tannur*	dung	Anderson *et al*. 1998
Other			
Malyan (Iran)	*towa* and hearth	straw, sesame stem, herbaceous plants	Miller 1982
Delta district (Egypt)	oven	dung (stem of corn and cotton to start fire)	Rizqallah and Rizqallah 1978
Machay (Uzbekistan)	*tannur*	cow's dung	Author (summer in 2015)

purposes [Miller 1982: 89–91].

Owing to its ability to confine heat, the dung is sometimes irreplaceable with the other kinds of fuel. In southern Levant, the *tabun* oven requires dung as a fuel to cover its outer wall and retain the heat [McQuitty 1984; McQuitty 1993]. The Jebala people in Morroco use wood as a fuel for daily heating and cooking, and dung as a fuel for pottery-making. The unfired pottery piled up in an earthen hollow is first covered with the dried dung cakes, and then with the fresh dung to regulate the heat. The wood is often used to light the dung; in one village, the bottom of the hollow is filled with wood before putting the pottery. The fig wood is specifically selected for this purpose because it produces less heat, which is suitable for the type of the clay used in pottery [Peña *et al*. 2003: 170–171].

As mentioned above, people carefully select different fuels for different purposes. The choice of the fuel is influenced mainly by 1) the heating time and 2) the type of fuel-firing facility. Other factors include the amount of smoke, temperature, and so on. Of course, the environmental and economic limitations, such as the scarcity of wood, seasons, or lack of domestic animals, are considered first, but these two factors seem to affect the choice of fuel even when the options of fuel are limited.

Various kinds of fuel are used for producing open fire in hearths than in ovens, except in bread-baking on a metal plate. In Kizilkaya, all eight types of dung fuel can be used in hearth (*ocak*),

but only five are used in bread oven (*tandır*). Most ethnographical records show that the dung is not usually used as a fuel in ovens. Once an oven is heated, it can confine heat inside, eliminating the need for long-lasting fuels; however, quick-burning type fuels are more convenient. In the regions where dung is used as a fuel in ovens, the choice is made on the basis of the environmental conditions (scarcity of wood or forbidden deforestation).

The cultural preferences also affect the choice of fuel, but on the whole, ovens demand quick- and lighter- burning fuels, whereas for hearths, one can choose a suitable fuel depending on what to cook or heat. Dung is primarily used as a fuel for open hearths, especially in long-time cooking and boiling.

Choice of fuel in archaeological sites

The selection of appropriate fuel for managing various activities, such as cooking, heating, lighting, fumigating, drying, and manufacturing, has been performed since the prehistoric times. It has been demonstrated by the use of two different fuels in Tell Ghanem al-Ali, an Early Bronze Age site located in the Middle Euphrates, 50-km east of the modern city of ar-Raqqa (Fig. 1). The author investigated the macro-botanical remains from three main trenches of this site, and the results showed a clear difference in the choice of fuel between the trenches in the uppermost Phase 3 (EBIVb).

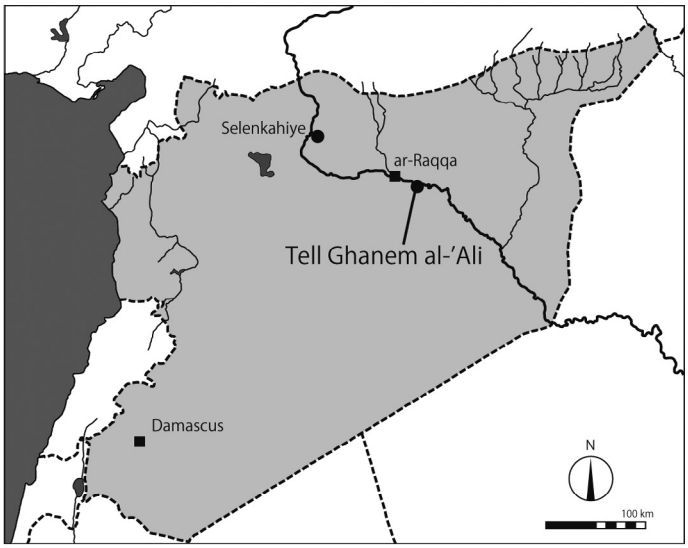

Fig. 1 Location of the sites mentioned in this paper

In squares 1 and 2, the ordinary houses comprising multiple rectangular rooms with stone foundation were excavated, and several round firing installations and hearths were recovered. In square 7/8, a building (5 m by 9 m) of somewhat different nature was found. Its northern room was equipped with three round firing installations in a row along the northern wall, and three plaster basins, also in a row along the mud-brick wall separating the building. In the middle of the room, a large, circular ash pit with its bottom covered with flat stones was present [Hasegawa 2010].

In addition, a peculiar plant assemblage was found in the square 7/8 compared to the other squares (Table 2). The botanical samples obtained from the squares 1 and 2 reflected the traces of various

Table 2 Plant remains from Tell Ghanem al-Ali, phase 3

	Square 1	Square 2	Square 7/8
Number of remains	12,282	6,485	3,301
Seed-to-charcoal ratio*	18	15	2
barley to other food plants	22:1	2:1	156:1
Grain-to-rachis ratio	20:1	4:1	89:1
Percentage of wild taxa**	42%	52%	23%
Major wild taxa	Chenopodiaceae	Fabaceae, Chenopodiaceae	Polygonaceae

* Seed-to-charcoal ratio = number of wild seeds/amount of charcoal.

** *Aizoon* seeds were excluded as many uncharred seeds were contained in the samples.

activities in these areas. The most predominant crop was barley, but grape pips were also abundant. Among the wild species, *Prosopis*, *Astragalus/Trigonella*, *Atriplex*, and *Suaeda* were found in large number, and these four species alone accounted for 45–61% of the wild taxa; however, these species were scarce in the square 7/8, where Polygonaceae seeds were the most predominant (30%) (Fig. 2).

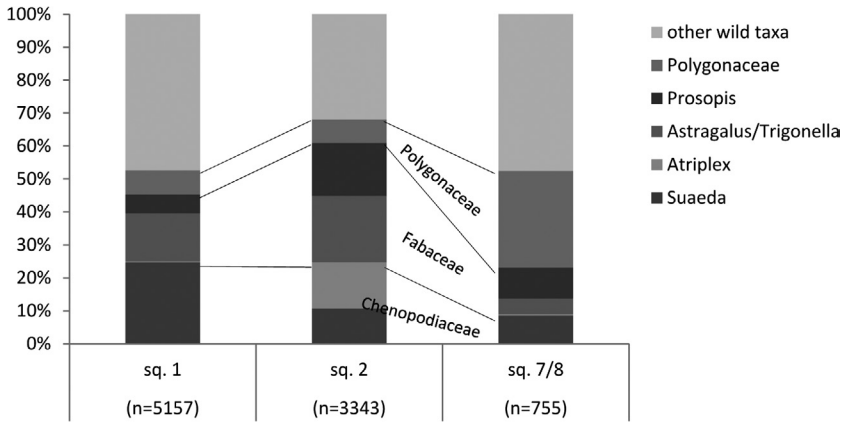

Fig. 2 Wild plant assemblage of Tell Ghanem al-Ali

The seed: charcoal (S:C) ratios of the squares 1 and 2 were found to be seven to nine times higher than that of the square 7/8. An increase in the usage of the dung fuel is suggested with an increase in the S:C ratio (Miller 1984). Two of the samples were particularly likely to be the dung fuel residue, because of the presence of coprolites and abundance of *Prosopis*, which is not likely a weed. Moreover, many *Suaeda* seeds were found covered with dung tissue in these samples. It is likely that the dung and wood were used as daily fuels for cooking and heating in the squares 1 and 2.

On the other hand, in the square 7/8, more specialized use of the fuels was implied by an archaeobotanical study. The soil samples were taken mainly from the northern room. Most of the macro-remains were barley grains (76%), accompanied by a small portion of the wild taxa (23%), and only a few rachises. Wild seed-to-charcoal ratio in the square 7/8 was found to be much lower than that in the other squares. The predominance of barley grains, scarcity of chaff and straw, low percentage of wild taxa, assemblage of wild species, and abundance of charcoal indicate that this room was dedicated to cooking or processing of barley using wood as fuel.

Interpretation of firing installation and cooking method with fuel

The difference in the choice of fuel in each square indicates the different use of firing facilities. The round, conical, or cylindrical firing features are so common in archaeological sites all over West Asia from the Neolithic to the Islamic period. Very little attention has been paid to the definition, classification, or understanding of the actual use of these features probably because they are so common.

Most scholars assumed that those installations were bread ovens owing to their similarity to the modern *tannur*. However, besides Tell Ghanem al-Ali, Grids W12/13 of Selenkahiye is only other example in the Early Bronze Syria that archaeobotanical assemblage supported that those installations were involved in the cooking/processing of cereals [van Zeist and Bakker-Heeres 1985/86]. It was not clear whether such round firing installations were actually used to bake bread and not to cook meat or vegetables, or whether they were ovens and not hearths when the upper parts of the firing facilities were missing. A number of ethnographical examples have shown that the *tannur* was used as a hearth as well by putting a pot on its upper opening. Besides, there are many types of processed

cereals, such as porridge, roasted grain, *bulgur*, and so on. In West Asia, bread is the current staple food; however, various kinds of porridge recipes are listed in the cookbooks of the Middle Ages [e.g. Arberry 1986; Nasrallah 2010; Perry 1986].

The reconstruction of the fuel used might be able to clear this point. The motif in choice of fuel demonstrated in the ethnographical records probably would have prevailed in the Bronze Age as well. If both wood and dung were used as fuels, wood was more likely to be chosen for ovens or short-time cooking. Dung fuel indicates long-time heating involved in cooking foods such as porridge or stew. In a domestic space, where multiple activities are conducted, such an explanation might be complicated. However, if the space was used for limited purposes, like the square 7/8 of Tell Ghanem al-Ali, the reconstruction of fuel will be simpler with macro-botanical, micro-botanical, and archaeogeological analyses. The choice of fuel can be regarded as an important clue to interpret the actual use of the firing facilities and cooking methods in the past.

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